Environmental Science and Policy 95 (2019) 20–27

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

The interplay between urban mitigation and adaptation strategies to face climate change in two European countries

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ARTICLE INFO

Keywords:
Urban adaptive capacity
Urban resilience
SECAPs
Adaptation strategies
Mitigation strategies

ABSTRACT

The growing recognition of the contribution of urban areas to adaptation and mitigation strategies implemented in response to climate change has led to several policy initiatives. Among others, the “Covenant of Mayors for Climate and Energy” is the most acknowledged, providing local governments with the opportunity to overcome the mitigation-adaptation dichotomy and enhance urban resilience. In this context, the main aim of this paper is to analyse the synergy between adaptation and mitigation actions in some European Sustainable Energy and Climate Action Plans at an urban level. We will do this through: (1) the proposal of a novel classification model of climate change mitigation and adaptation measures, which will be capable of classifying, in a common way, the best practices carried out at an urban level; and (2) a comparison of the best climate change management practices carried out by two European countries (Italy and Spain). The classification model is based on three urban sectors: (1) Urban Adaptation and Health (UA&H), (2) Transport & Infrastructure (T&I), and (3) Energy (NRG). Urban management measures have been classified as soft (more focused on environmental information), gray (more focused on buildings), and green (more focused on nature-based solutions). The overall comparative analysis between Italy and Spain shows that in large and medium-sized Italian cities, mainly soft (52%) and green (28%) adaptation measures have been integrated into local energy-environmental planning in combination with mitigation actions. However, in both countries, decisions regarding the type of measures to be implemented are taken independently of the size of the city. This paper, in line with other research, highlights the importance of nature-based solutions as a first step in the integration process between adaptation and mitigation strategies at an urban level.

1. Introduction

Rapid population growth and socio-economic development in nearly all regions of the Earth have drastically affected the landscape and its resources (Vitousek et al., 1997), but only since the mid-20th century has the impact of these transformations become visible on a global scale, having brought about the destabilization of the Holocene epoch and the birth of a new era called Anthropocene (Steffen et al., 2015). Among the different drivers of global landscape change, climate change is receiving great attention at all institutional levels (from local to global) and temporal scales, through short- and long-terms strategies, since it represents a threat to socio-environmental security (Aguiar et al., 2018). This recognition has resulted in the proliferation of adaptation and mitigation measures that are useful in facing changing conditions and new risks and enabling communities to adapt and respond to rapid-worldwide-climate-change issues (Fazey et al., 2018).

1.1. Adaptation and mitigation strategies

The definition of mitigation and adaptation provided by the Intergovernmental Panel on Climate Change (IPCC) reinforces the two strategies' separateness: mitigation has the potential to affect the causes of climate change and has been defined as *“[…] anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases”* (IPCC, 2014). On the other hand, adaptation aims at reducing local vulnerability to climate change and has been defined as *“[…] adjustment in natural or human systems in response to actual or expected climate and its effects”* (IPCC, 2014). According to the above definitions, mitigation would be mainly aimed at addressing global long-term problems, while adaptation at resolving local and short-term problems.

However, adaptation and mitigation strategies, when integrated, can affect the overall vulnerability of socio-ecological landscapes to climate change. Specifically, adaptation measures can support the

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https://doi.org/10.1016/j.envsci.2019.02.002
Received 10 October 2018; Received in revised form 11 February 2019; Accepted 11 February 2019
Available online 16 February 2019
1462-9011/

adaptive capacity and resilience of socio-ecological landscapes, i.e. the ability of a system to absorb disturbances and reorganize itself while undergoing change so as to retain essentially the same function, structure, identity, and feedback (Walker et al., 2004). On the other hand, mitigation measures can affect the drivers (i.e., character, magnitude, and rate) of climate change to which a socio-ecological landscape is exposed (Parry et al., 2007). Therefore, the initiatives addressing climate change cannot enhance resilience (adaptation) unless they integrate mitigation into their activities.

As suggested by Fazey et al. (2018) many resilience initiatives focus primarily on addressing the symptoms (effects) of climate change rather than the drivers (causes). Furthermore, despite the fact that the problem of climate change has been widely debated, very few scientific papers have focused specifically on the relationship between climate change and resilience.

It is recognized that urban areas host drivers of global warming, given the everyday activities carried out in such places (Seto et al., 2014; Pasimeni et al., 2014; Croci et al., 2017), but they can also be affected by climate change, in terms of predictable (e.g., constant temperature rise) and unpredictable disturbances (e.g., weather extremes) (Peterson, 2002; Zurlini et al., 2013). At a local level (i.e. city level), effective mitigative as well as adaptive actions necessarily involve decisions by individuals (Swart and Raes, 2007; Raymond et al., 2017). In this context, the criticism levelled at adaptation measures that are seen as an accommodating change approach, rather than combatting it, is overridden by mitigation measures, which are more likely to directly challenge the drivers of climate change (Cameron, 2012; Pelling, 2011). Therefore, as highlighted by the Conference of Parties (COP) 21 held in Paris in 2015, the networking of urban areas can represent the most crucial place for testing innovative solutions as strategies to reduce (mitigation) and to cope with (adaptation) the effects of climate change (Marshall, 2008; Laukkonen et al., 2009; Hoornweg et al., 2011; Romero-Lankao, 2011; UNFCCC, 2016; Castán Broto, 2017).

In this context, the “Covenant of Mayors”, a voluntary initiative launched in 2008, represents the most important global movement, at the local level, in the framework of the Europe 2020 Climate and Energy Strategy, since many cities contribute to climate change mitigation through energy saving and the use of renewable energy sources, to give two examples. (Oteman et al., 2014). On the other hand, the “Mayors Adapt”, launched in 2014 in the framework of the EU Adaptation Strategy, has the overall aim of promoting urban leadership in adaptation initiatives enhancing resilience to climate change by identifying the best ways to adapt to possible climate change risks (Revi et al., 2014). However, the adoption and implementation of both adaptation and mitigation measures suffer from institutional inertia in local policy practice (Hoppe and Van Bueren, 2015; Castán Broto, 2017).

In order to strengthen the synergy between mitigation and adaptation strategies, and to support local governments in taking an effective path towards a more resilient future, in October 2015[1], the “Covenant of Mayors” and “Mayors Adapt” initiatives were merged, forming the new “Covenant of Mayors for Climate and Energy”[2] . This represents the biggest urban climate and energy initiative worldwide, where local authorities voluntarily tend to implement EU climate and energy targets and to adopt an integrated approach to urban planning. In 2017, the “Covenant of Mayors for Climate and Energy” became the “Global Covenant of Mayors for Climate and Energy” by extending its application worldwide.

Schematically, the three most important steps that a city must undertake are (Covenant of Mayors Office (CoMO, 2016): (1) the collection of the baseline emission inventory; (2) SECAP (Sustainable Energy and Climate Action Plan) development with short-, medium-, and long-term actions; and (3) monitoring progress to report on SECAP implementation, since it is an important opportunity to identify best practices, which are collected in the “Good Practices” database[3] in order to provide visibility to specific mitigation and adaptation actions that have been implemented. This is done to enhance knowledge sharing and self-assessment by attempting to “lead by example” (Bulkeley and Kern, 2006).

Given the difficulty in translating policy into concrete actions, cities test best practices in order to try new ideas and methods, to understand how they work in practice and how they can be transferred to new contexts. The purpose of this is to obtain new knowledge of local, national and international climate and sustainability governance (Brown and Vergragt, 2008; Evans, 2011; Hoffmann, 2011; McFarlane,2011; Castán Broto and Bulkeley, 2013). This adaptive approach based on “learning by doing” has enabled cities to take advantage of the practical experience gained through their role in facing climate change (Bulkeley et al., 2014; Rutherford and Coutard, 2014). In this sense, the new “Covenant of Mayors for Climate and Energy” can be considered a collection of “climate change experiments” (Bulkeley and Castán Broto, 2013) performed by a large group of local governments to better plan decisions in terms of energy savings, renewable energy production, GHGs emissions reduction, and efforts to improve resilience of urban cities to climate change.

In line with the most recent research, which has shown the growing interest in assessing climate adaptation and mitigation plans at the local level (Olazabal et al., 2014; De Gregorio et al., 2015; Geneletti and Zardo, 2016), the main aim of this paper is to analyse the synergy between adaptation and mitigation actions in some European SECAPs at urban level, through the proposal of a novel classification model of climate change mitigation and adaptation measures, able to classify in a common way the best practices carried out at urban level. In this sense this new classification model can support local planning processes in researching the balance and interdependencies between climate adaptation and mitigation strategies and exploiting the co-benefits deriving from their synergy (Mi et al., 2019). This common classification has been the basis for comparing the best mitigation and adaptation management practices carried out on a local scale by two European countries (Italy and Spain).

2. Material and methods

2.1. Study areas: selection criteria for comparing Italy and Spain

Italy and Spain have been selected for their similar vulnerability to climate change: 84% of Italian and Spanish cities have a vulnerability index of 4 or higher, on a scale from 1 (low) to 5 (high) (ESPON, 2011). Consequently, it is reasonable to assume that Italian and Spanish cities face similar challenges in mitigating and adapting to climate change and, therefore, should implement similar policies.

More specifically, since 2010, adaptation measures to deal with climate change have been included in some Italian strategies, such as the “National Biodiversity Strategy”, the “Strategy for the marine environment”, the White Paper on “Challenges and opportunities of rural development for climate change mitigation and adaptation”, and the “Guidelines for preparing monitoring and response plans to the health effects of abnormal heat waves”. In addition, the Italian National Adaptation Strategy (NAS) was approved in 2015 on the basis of the EU Adaptation Strategy requirements. The Italian National Action Plan (NAP) was submitted for public consultation and scientific review on February 2017 (European Environmental Agency (EEA, 2018a).

As early as 2006, a National Plan for Adapting to Climate Change

[1] http://www.covenantofmayors.eu/about/covenant-initiative/origins-and-development.html

[2] https://www.globalcovenantofmayors.org/about/

[3] http://www.covenantofmayors.eu/plans-and-actions/good-practices.html

was approved and adopted in Spain, and it still represents the reference framework for the development of national adaptation strategies. It is developed through specific Work Programmes, which include all sectors and natural resources recognized as potentially affected by climate change. The most recent Third Work Programme, adopted and approved in 2014, is fully coherent with the EU Adaptation Strategy (European Environmental Agency (EEA, 2018b).

Definitively, both countries have developed analogous approaches towards the EU Adaptation Strategy, and they are the countries with the greatest number of cities joining the "Covenant of Mayors for Climate and Energy" initiative (of the total EU signatory cities, 55% are Italian and 25% are Spanish). Consequently, they have the highest number of cities with the SECAP (Sustainable Energy and Climate Action Plan) in the monitoring step – 54% in Italy and 27% in Spain.

2.2. The selection of best practices implemented by large and medium-sized cities

In order to understand the possible synergies between adaptation and mitigation measures at local level, data regarding the "Best Practices" collected from SECAPs at the monitoring step on May 2017 were analysed. The sample took account of the "Best practices" implemented by all Italian and Spanish large (> 250,000 in.) and medium-sized (50,000–250,000 in.) cities, joining the "Covenant of Mayors for Climate and Energy" (Table 1).

2.3. Common classification model of the best practices carried out at urban level

In this research the best practices, collected from Italian and Spanish SECAPs, and classified according to the national adaptation strategies and plans have been translated into a novel and common classification model based on three urban sectors (Fig. 1): (1) Urban Adaptation and Health (UA&H), which is characterized by adaptation measures and is subjected to the negative effects of climate change. It is based mostly on artificial systems, therefore, the resilience of this sector is under human control and must be assured almost exclusively by human action and by an increase in the active involvement of citizens; (2) Transport & Infrastructure (T&I), which is characterized by adaptation measures and is fundamental for the maintenance and the functioning of society, since it guarantees the movement of people, goods and services; and (3) Energy (NRG), which is the sector mainly characterized by mitigation measures since it has been the focus of international mitigation policies and strategies. In addition, each best practice has been further classified into (Fig. 1): (1) "Soft measures" (SO) i.e., awareness-raising and communication of possible actions both at individual and collective levels to adapt, or involving management, legal and political approaches; (2) "Gray measures" (GY) i.e., technological, engineering or structural solutions; (3) "Green measures" (GN) i.e., ecosystem-based approaches, or nature-based solutions, to restore the ecological balance within the urban landscape and to develop more resilient territories.

Table 1
Italian and Spanish Large and Medium-sized cities included in the study.

	Italy	Spain
Medium-sized cities	Bergamo	Badalona
50,000 – 250,000 in.	Cinisello Balsamo	Castelldefels
	Collegno	Cerdanyola del Vallès
	Forlì	Cornellà de Llobregat
	La Spezia	El Prat de Llobregat
	Unione dei Comuni Nord Est Torino – NET[§]	Elche
	Olbia	Granollers
	Padova	Logroño
	Ravenna	Lorca
	Rho	Manresa
	Salerno	Mataró
	Treviso	Mollet del Vallès
	Trieste	Rubí
		Sant Boi de Llobregat
		Sant Cugat del Vallès
		Santa Coloma de Gramenet
		Santa Cruz de Tenerife
		Santander
		Terrassa
		Viladecans
		Vilanova i la Geltrú
TOTAL Medium-sized cities	**13**	**21**
Large-sized cities	Bologna	Barcelona
> 250,000 in.	Firenze	L'Hospitalet de Llobregat
	Genova	Málaga
	Milano	Murcia
	Torino	Valencia
	Verona	
TOTAL Large-sized cities	**6**	**5**

[§] Participating cities: Borgaro, Caselle, Leinì, San Benigno, San Mauro, Settimo and Volpiano. The total territory extends over 170 km^2 and the total population amounts to about 135,000 in.abitants.

2.4. Statistical analysis

The comparison of the best practices implemented by Italian and Spanish cities under study was carried out through log-odds ratios (Agresti, 1996). In particular, log-odds ratios were calculated to test statistically significant differences between Italy and Spain for each type of measure (Soft - SO, Gray - GY and Green - GN). Finally, log-odds ratios were calculated for each type of measure (SO, GY and GN) to test statistically significant differences between large and medium-sized cities.

3. Results

3.1. The application of the common classification model to Italian and Spanish "best practices"

A detailed description of each measure in the new classification model is shown in Table 2. The model has been applied to the sample, which includes a total of 185 "Best Practices", adopted by all Italian and Spanish Large and Medium-sized cities.

Specifically, the Urban Adaptation and Health (UA&H) sector presents eight soft, three gray and three green measures. The Transport and Infrastructure (T&I) sector includes five soft, four gray, and three green measures. Finally, in the Energy (NRG) sector there are only six soft and two gray measures. Since there is an inherent interaction among sectors, it is obvious that some measures could have an impact on more than one single sector.

The novel classification model has been applied to the sample represented by 185 "Best Practices", adopted by all Italian and Spanish large and medium-sized cities. As highlighted in Table 3, "Best Practices" classified within the Urban Adaptation and Health (UA&H) sector represent 58% of the total actions analysed and have been classified mainly as soft (53%) and green (43%) measures in Italy, and only as soft measures (86%) in Spain. In particular, soft measure UA&H_SO6 – improving the energy performance and resilience of public and private buildings – is prevalent in both countries, but in the Italian context, it is associated with UA&H_GN1 measure, which is a green measure related to the promotion of green roofs and to the increasing of public and private green areas. On the other hand, in Spain it occurs with another soft measure, UA&H_SO1, which is related to the increased awareness among citizens of the risks of climate. In general, little attention is given to Gray measures by both countries (Table 3).

"Best Practices" adopted by Italian and Spanish large and medium-

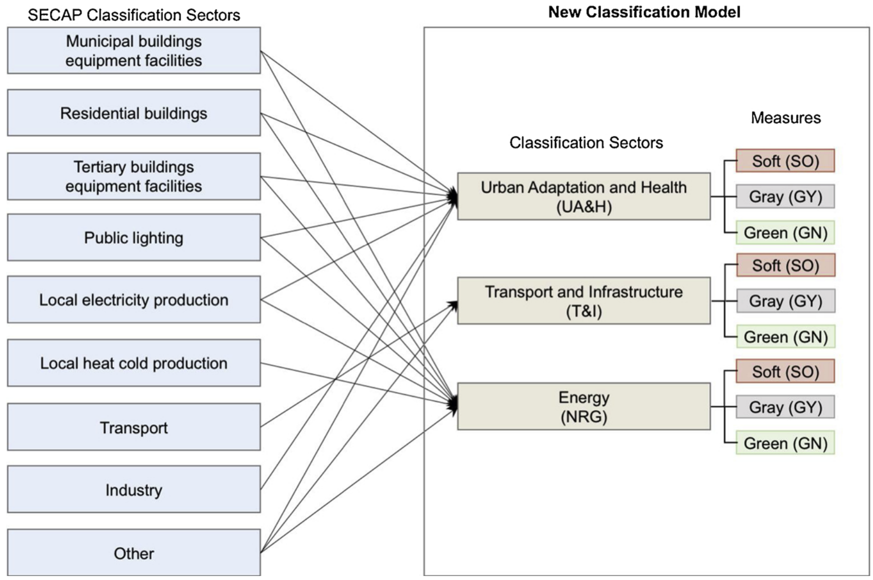

Fig. 1. Scheme of the new common classification model of "Best Practices" included in Italian and Spanish SECAPs (Sustainable Energy and Climate Action Plans).

sized cities, and classified in Transport and Infrastructure (T&I) sector, represent only 15% of total best practices (Table 3). In this case only one measure (T&I_SO4) interests both countries, with a percentage of 46% for Italy and 54% for Spain. Specifically, this measure refers to the promotion of adaptation to climate change in sectorial transport plans at local level, by facilitating sustainable mobility and promoting efficiency in private and public transport. In Italy, it occurs together with one green measure, T&I_GN3, which is related to the integration between green infrastructures and cycling and pedestrian mobility, and one gray measure, T&I_GY3, which relates to support for the adaptation to climate change of the public transport supply. In Spain, instead, it occurs together with gray measure T&I_GY4, which is focused on the creation of infrastructural facilities for cycling and pedestrian mobility.

The "Best Practices" classified in the Energy (NRG) sector represent 27% of the total actions analysed (Table 3). In Italy they are more or less equally distributed among soft (53%) and gray (46%) measures. In Spain, however, soft measures represent the predominant actions adopted by large and medium-sized cities (85%), with NRG_SO3 as the prevailing soft measure (61%). This last measure refers to the monitoring of energy consumption.

For the comparative statistical analysis between Italy and Spain, all log-odds are calculated for each type of measure with reference to the "Best practices" undertaken by Spanish large and medium-sized cities, and they show a statistically significant difference between Italy and Spain (Table 4). Green measures have the highest positive log-odds, indicating that Italian cities are more likely to undertake this type of measure, whereas soft measures have the highest negative log-odds, demonstrating that they are most likely to be adopted by Spanish cities, which focus on managerial, legal and political approaches (Table 4). The Italian preference for green measures highlights a national effort to enhance the synergy between adaptation and mitigation strategies. Therefore, in Italian large and medium-sized cities, mitigation measures are integrated into local energy-environmental planning processes with measures based on ecosystem-based approaches, or nature-based solutions, capable of enhancing the adaptive capacity of the urban landscape and of supporting more resilient socio-ecological landscapes.

Furthermore, all log-odds for the city-sizes considered showed no statistically significant differences between countries (Table 5), thus the choice between adaptation and mitigation measures can be taken independently of the size of the cities.

4. Discussion

The new model of discriminating between soft, gray and green measures facilitates identification of the main local approaches and efforts to mitigate the effects of climate change. It also allows for a strengthening of the adaptability of the most vulnerable sectors, by promoting their resilience in urban areas. The type of measures chosen by local governments can give insights into the evolution of the interplay between adaptation and mitigation strategies at an urban level.

The overall comparative analysis between Italy and Spain (Fig. 2) shows that in Italian large and medium-sized cities, mainly soft (52%) and green (28%) measures have been integrated into local energy-environmental planning processes in synergy with mitigation actions. On the other hand, Spanish large and medium-sized cities are mainly oriented towards "soft" approaches (81%), aimed at awareness-raising and the communication of possible adaptation actions at individual and community level.

The novel classification model, by linking adaptation and mitigation strategies, includes measures acting at different spatial scales, from building envelopes to large infrastructures and green corridors. Nevertheless, all such measures fall within the scope of energy and environmental planning in synergy with mitigation actions. In this sense, considering cities as part of the biggest challenge of sustainable development, the novel classification model can better support urban planning by encouraging proactive action on climate change that incorporates synergistic mitigation and adaptation actions. Measures proposed consider socio-economic and environmental relevance, as well as the vulnerability of cities to the effects of climate change. These are also measures that provide benefits regardless of the extent of climate change as they promote, protect and enhance natural processes and ecosystem services. In particular, "Best practices" classified as

Table 2
Classification model of urban measures.

Classification	Types of measures		
Sectors	Soft (SO)	Gray (GY)	Green (GN)
Urban Adaptation and Health (UA&H)	UA&H_SO1: Increasing awareness about climate change risks and participation in adaptation actions of stakeholders. UA&H_SO2: Varying settlement and infrastructure predictably exposed to climate impacts.	UA&H_GY1: Promoting experimentation of new settlement models able to cope with climate change. UA&H_GY2: Intervening in hydraulically critical settlements by maintaining and strengthening drainage networks and connected plants.	UA&H_GN1: Promoting the spread of green roofs and the increase of public and private green areas. UA&H_GN2: Realizing experimental interventions on the public spaces adaptation in particularly vulnerable areas.
	UA&H_SO3: Promoting monitoring and warning systems for extreme events in urban areas.	UA&H_GY3: Favouring the security of existing and strategic importance infrastructures.	UA&H_GN3: Promoting spread of urban gardens, both for educational purposes and for green areas retraining
	UA&H_SO4: Promoting the creation of urban adaptation strategies and plans. UA&H_SO5: Supporting air quality restoration policies and measures that determine adaptation benefits. UA&H_SO6: Improving energy performance of public and private buildings. UA&H_SO7: Establishing environmental and energy sustainability standards in urban area planning. UA&H_SO8: Encouraging scientific research on climate adaptation of urban areas.		
	T&I_SO1: Strengthening communication, information, and training on climate-proof infrastructures.	T&I_ GY1: Identifying points of the road network at flooding risk.	T&I_GN1: Green Infrastructures.
Transport and Infrastructure (T&I)	T&I_SO2: Developing climate change adaptation tools in the transport sector. T&I_SO3: Spreading the risks by compensation mechanisms.	T&I_GY2: Building and maintaining roads under climate change threat. T&I_GY3: Promoting interventions of adaptation to climate change to increase the supply of public transport.	T&I_GN2: Green Infrastructures – Maintaining corridors and greenbelts. T&I_GN3: Public transport infrastructures – Integration between green infrastructures and cycling and pedestrian mobility.
	T&I_SO4: Promoting adaptation to climate change by facilitating sustainable mobility. T&I_SO5: Encouraging scientific research and set up a scientific committee for risk mapping.	T&I_GY4: Increasing infrastructural facilities for cycling and pedestrian mobility.	
	NRG_SO1: Strengthening communication, information, and training on adaptation to climate change in the energy sector.	NRG_GY1: Making energy efficiency works and actions for the production and use of renewable sources.	
Energy (NRG)	NRG_SO2: Developing a methodological guide on climate change mitigation tools in the energy sector. NRG_SO3: Reinforcing systems for monitoring energy production and energy consumptions to mitigate the contribution of the energy sector on climate change. NRG_SO4: Managing energy demand for heating and cooling through economic incentives. NRG_SO5: Increasing resilience of the energy system through mitigation measures. NRG_SO6: Management of electric power transmission and distribution.	NRG_GY2: Management of energy demand for heating and cooling through the construction of plants.	

"soft" and "green" measures produce both mitigation and adaptation benefits. In this sense, improving the energy performance and resilience of buildings is a key component of climate change mitigation, but also a key component of adaptation, because indoor heating and cooling is becoming increasingly challenging, as cities need to adapt to global warming and weather extremes.

Moreover, a sustainable and more resilient urban transport system is beneficial for climate change mitigation but is also capable of guaranteeing more resilience-capacity in the face of increasing climate risks to critical infrastructure. The integration between green infrastructure and cycling and pedestrian mobility can enhance environmental efficiency in private and public transport. Specifically, the main function that green infrastructure can discharge in urban areas is to provide ecosystem services such as carbon sequestration and pollution control, by sequestering GHGs (Chenoweth et al., 2018) as well as supporting social capital (Harrington and Hsu, 2018).

Finally, rewilding urban spaces contributes to climate change mitigation because urban green areas serve as "carbon sinks", but this is also a key component of adaptation, as it increases the absorptive capacity of soil in the case of heavy rainfall and has a cooling effect on the built environment, among other benefits. This is in line with Lwasa et al. (2018) who, among the emerging pathways to enhance the synergy between adaptation and mitigation strategies, listed the creation of green urban infrastructure (support of natural capital), and the

Table 3
Percentage distribution of "Best Practices" classified in soft (SO), gray (GY) and green (GN) measures for each sector (UA&H-Urban Adaptation and Health, T&I-Transport and Infrastructure, NRG-Energy) between Large and Medium-sized cities in Italy and Spain. The prevailing measures are graphically highlighted. See Table 2 for description of acronyms and for the detailed characterization of each measure.

Classification Sectors	Types of measures	Italy M-sized cities	Italy L-sized cities	Italy Total	Spain M-sized cities	Spain L-sized cities	Spain Total	% of total "Best practices"
Urban Adaptation and Health (UA&H)	Soft (SO)							58%
	UA&H_SO1	6%	-	6%	19%	7%	26%	
	UA&H_SO6	30%	9%	39%	50%	2%	52%	
	UA&H_SO7	4%	4%	8%	6%	2%	8%	
	Total UA&H_SO	40%	13%	53%	75%	11%	86%	
	Gray (GY)							
	UA&H_GY1	4%	2%	6%	-	2%	2%	
	Total UA&H_GY	4%	2%	6%	-	2%	2%	
	Green (GN)							
	UA&H_GN1	15%	9%	24%	7%	4%	11%	
	UA&H_GN2	4%	2%	6%	-	-	-	
	UA&H_GN3	6%	6%	12%	2%	-	2%	
	Total UA&H_GN	25%	17%	43%	9%	4%	13%	
Transport and Infrastructure (T&I)	Soft (SO)							15%
	T&I_SO4	33%	13%	46%	31%	23%	54%	
	Total T&I_SO	33%	13%	46%	31%	23%	54%	
	Gray (GY)							
	T&I_GY3	13%	7%	20%	-	-	-	
	T&I_GY4	-	7%	7%	23%	8%	31%	
	Total T&I_GY	13%	14%	27%	23%	8%	31%	
	Green (GN)							
	T&I_GN1	-	-	-	-	8%	8%	
	T&I_GN3	20%	7%	27%	8%	-	8%	
	Total T&I_GN	20%	7%	27%	8%	8%	16%	
Energy (NRG)	Soft (SO)							27%
	NRG_SO1	4%	8%	12%	-	-	-	
	NRG_SO3	4%	4%	8%	38%	23%	61%	
	NRG_SO4	8%	4%	12%	8%	-	8%	
	NRG_SO5	17%	4%	21%	12%	4%	16%	
	Total NRG_SO	33%	20%	53%	58%	27%	85%	
	Gray (GY)							
	NRG_GY1	17%	8%	25%	4%	4%	8%	
	NRG_GY2	17%	4%	21%	8%	-	8%	
	Total NRG_GY	34%	12%	46%	12%	4%	16%	

opportunities of inclusiveness for all social groups (support of social capital) as an added value in the context of urban energy-environmental planning.

5. Conclusions

Local climate action has become an important feature of European climate governance, thus cities will have to carry out additional experiments to test best practices and try new ideas and new methods. In this context, the new "Covenant of Mayors for Climate and Energy" represents, to date, a collection of local climate change experiments providing a publicly available database of multilevel climate best practices to increase the understanding and promotion of local adaptation action in Europe and beyond (Kern, 2019). Despite the fact that several cities have put effort into finding the best solutions to mitigate the effects of climate change, these actions also need to be consistent

Table 4
Odds ratios, log-odds ratios, approximate confidence limits and z-values for odds ratios significance are given for each typology of measures. Odds ratio and log-odds ratios refer to the "Best practices" undertaken by Spanish Large and Medium-sized cities.

Typology of measures	Odds ratio	log-odds ratio	Conf. Limits[§]	z-value[ς]
Soft (SO)	0.303	−1.194	[−1.861; -0.526]	−3.504[**]
Gray (GY)	2.471	0.904	[0.043; 1.766]	2.057[*]
Green (GN)	2.828	1.040	[0.189; 1.890]	2.397[**]

§ Approximate 95% confidence limits for the log-odds ratios.
ς P-value is the area of the normal distribution that falls outside ± z: * P-value < 0.05; ** P-value < 0.01.

Table 5
Odds ratios, log-odds ratios, approximate confidence limits, variance and z-values for odds ratios significance are given for each typology of measures in Large and Medium-sized cities. Odds ratio and log-odds ratios refer to the “Best practices” undertaken by Spanish Large and Medium-sized cities.

Typology of measures	Medium-sized cities				Large-sized cities				z-value[ς]
	Odds ratio	log-odds ratio	Conf. Limits[§]	Variance	Odds ratio	log-odds ratio	Conf. Limits[§]	Variance	
Soft (SO)	0.314	−1.157	[-1.978; −0.337]	0.175	0.328	−1.114	[-2.295; 0.067]	0.363	−0.059
Gray (GY)	2.955	1.083	[0.031; 2.135]	0.288	1.583	0.460	[-1.051; 1.971]	0.594	0.664
Green (GN)	2.355	0.857	[-0.224; 1.937]	0.304	3.167	1.153	[-0.282; 2.588]	0.536	−0.323

§ Approximate 95% confidence limits for the log-odds ratios.
ς P-value is the area of the normal distribution that falls outside ± z: * P-value < 0.05; ** P-value < 0.01.

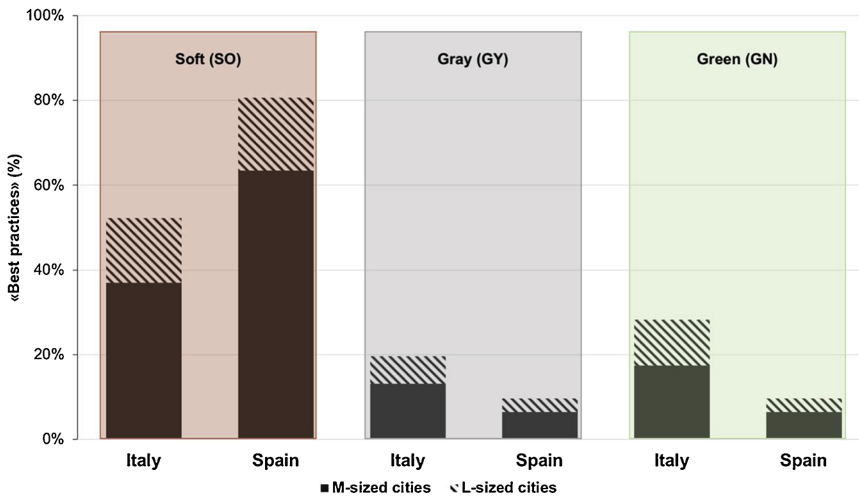

Fig. 2. Percentage of “Best Practices” classified in each typology of measures (SO-Soft, GY- Gray, GN – Green, for details see Table 2), where the total number of Italian actions is 92, and the total number of Spanish actions is 93.

with adaptation actions (Picketts et al., 2013). The findings of this research are in line with the most recent research (Fazey et al., 2018; Reckien et al., 2018; Mi et al., 2019) which highlighted the urgent need to meet the gap of knowledge regarding how the synergistic implementation of adaptation and mitigation measures into local planning process has contributed to efforts to mitigate the effects of environmental change. The novel classification model proposed in this research represents a starting point to help local governments improve their climate-environmental planning through a validated set of synergistic best management mitigation and adaptation measures. This will aid policymakers in identifying innovative solutions for making urban systems more resilient to climate change through a holistic and systemic approach that takes cognisance of the complex interactions of multiple dimensions of global environmental change. i.e. How to "adapt" to and "mitigate" the effects of climate change while maintaining the essential aspects of human well-being, social and natural capital.

Acknowledgements

We strongly thank the anonymous reviewer for his helpful and targeted comments and for his precious contribution in improving the original version of the manuscript.

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